CE 553: Biological Processes in Environmental Engineering

Fall 2014, Mondays 3:30 – 6:10 pm, KAP 159

Course Description: Design of biological treatment processes with a focus on removing organic and inorganic pollutants and recovering resources (i.e., energy, water, nutrients, and other useful products). Aerobic and anaerobic as well as suspended and attached growth technologies are emphasized. Computational models to facilitate design are introduced. Prerequisite: CE 453 or equivalent or consent of instructor. 3 credits.

Course Objectives: By the end of this course, the student will be able to:

- Describe unit processes used in biological treatment of waste streams
- Explain how unit processes work by understanding process engineering and microbiology of aerobic and anaerobic treatment systems
- Understand resource recovery strategies from waste streams
- Use biological process simulation software to design treatment systems

Instructor:

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Office hours: Tuesday 10:00 – 12:00 pm or by appointment

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates and the instructor. Rather than emailing questions to the instructor, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

Find our class page at: https://piazza.com/usc/fall2014/ce553/home

Required Textbook:

C. P. Leslie Grady Jr., Glen T. Daigger, Nancy. G. Love, and Carlos D. M. Filipe (2011), *Biological Wastewater Treatment Third Edition*. Co-published by IWA Publishing, London, UK and CRC Press, Taylor and Francis Group, Boca Raton, FL.

Additional Relevant Text Books:

• B. E. Rittmann and P. L. McCarty (2001), *Environmental Biotechnology: Principles and Applications*, McGraw-Hill, Inc., New York, NY.
Website for text: http://www.mhhe.com/engcs/civil/rittmann/ (includes an errata list). *Strongly Recommended – Great resource for students and practitioners.*

• G. Tchobanoglous, H. D. Stensel, R. Tsuchihashi, F. L. Burton, M. Abu-Orf, G. Bowden, and W. Pfrang (2014), *Wastewater Engineering: Treatment and Reuse*, 5th Ed., McGraw-Hill, Inc., New York, NY. *Strongly Recommended – Great resource for practitioners* (also referred to as Metcalf & Eddy).
• M. Henze, M. van Loosdrecht, G. Ekama, D. Brdjanovic (2008), *Biological Wastewater Treatment, Principles, Modeling, and Design.* IWA Publishing, London, UK. *Recommended – Individual chapters written by different experts.*

Homework:

Homework sets will be assigned to allow you to study material in more depth than possible in the exams. This may include material that has not been covered in depth in class and therefore, requires reading of the textbook or journal papers. You are encouraged to use references outside of the assigned reading materials but please cite the original source. Also, reference any assigned readings including the textbook appropriately.

You may work individually or as part of a group of up to 5 students. Each student must submit a solution regardless of working individually or in a group. Please list the other students you worked with (if any) on the cover sheet of your homework submission. The cover sheet is available on Piazza. I encourage students to also use Piazza to discuss homework assignments. Please offer guidance on homework questions (e.g., try solving for S_s using equation 5.53 and inputting that into equation 5.58), but do not directly answer questions.

Format:

1. Each submitted homework solution must include a cover page listing the name(s) and signature(s) of the participants who worked together on the solution. Your signature on the cover page certifies that you actively participated in the solution of *all* the problems in the homework set.
2. Use 8.5"x11" paper with straight edges, *not* paper torn from a spiral notebook.
3. Number all pages (e.g. 1/5, 2/5, etc.).
4. Use only one side of each page.
5. Begin each problem on a new page.
6. Box the final answers.
7. Staple all pages together.
8. Write and draw neatly and legibly!
9. For writing assignments, your answers should be typed (use 1.5 line spacing and 1" margins). Writing assignments are primarily evaluated for content, but writing effectiveness is also important (e.g., organization, style, grammar, punctuation, spelling, and neatness).
10. You are encouraged to use references other than the assigned reading material. When using information from these references in your homework, make sure to reference the original source using an appropriate reference format (e.g., check instructions for authors of research journals in our field, such as *Water Research* http://www.iwaponline.com/wr/i2a.htm).

Late Homework: Homework assignments will be posted on Piazza and due one to two weeks after they are assigned. Completed assignments are due at the beginning of class on the due date. If the homework cannot be turned in at the beginning of class on the due date, prior permission from the instructor to change the due date is necessary. Without permission, the homework will not be graded.

Study questions on Piazza:

Study questions will be posted to Piazza weekly. Please answer, respond, or comment on at least one question each week (more often is encouraged). There likely will not be enough questions for each student so please elaborate on existing answers as necessary in the event that all questions have been answered. Participation in Piazza discussion is mandatory and a component of your grade. Study questions posted on Piazza (or similar questions) may be on exams so please review all questions and responses.

Field Trip:

A field trip to the Hyperion Treatment Plant will take place on November 11 (tentative). The objective of this field trip is to evaluate design and operation of a full-scale treatment plant based on what you have learned in this class. Students will be in teams of 4-5 students. Each team will gather data on the plant's unit processes and operation to prepare a 10-12 page report on the plant (more details to come). Groups will also model the plant using BioWin based on the data gathered and include this in the report. In addition, a section of the report will review a new biotechnology that could be implemented at Hyperion to improve treatment performance, energy efficiency, environmental impacts, and/or costs. This section of the report will be presented to the class in a 20-30 minute PowerPoint presentation. New biotechnologies could include partial-nitritation/anammox (sidestream or mainstream), struvite precipitation, two-phase anaerobic digestion, anaerobic membrane bioreactor, microbial fuel cell, algae-based photobioreactors, or others. Please propose a topic by November 17 by emailing the instructor.

Exams:

All exams will be closed-book. You can make your own formula sheet for the exam. For Exam 1, you may use one double-sided sheet (2 pages); for Exam 2, you may use two double-sided sheets (4 pages); for the Final Exam, you may use three double-sided sheets (6 pages). Permission for a make-up exam must be obtained before the exam.

Grading:

A weighted average grade will be calculated as follows:

Homework	15%
Field Trip (report, modeling, and presentation)	20%
Exam 1	15%
Exam 2	15%
Final Exam	25%
Class/Piazza Participation and Professional Evaluation	10%

Re-grade: If you believe an error has been made in homework or exam grading, please bring it to the instructor's attention in writing first, then discuss during office hours or after making an appointment.

Additional Policies:

No photo, video, or voice recordings are allowed in the lectures without prior consent of instructor. Use of personal technology devices during the lecture are not recommended; usage of them may affect your class participation grade.

Statement for Students with Disabilities:

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity:

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Emergency Preparedness/Course Continuity in a Crisis:

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

Course Schedule (tentative):

Date	Topic	Exams, assignments, no class days, etc.	Reading
8/25	Introduction and background	HW 1 assigned	Notes
9/1		Labor day, no class	
9/8	Fundamentals, stoichiometry, and kinetics of biochemical operations	HW 1 due, HW 2 assigned	GDLF Ch. 1 and 2
9/15	Fundamentals, stoichiometry, and kinetics of biochemical operations (cont.)		GDLF Ch. 3 and 9.6
9/22	Theory: Modeling of ideal suspended growth reactors	HW 2 due	GDLF Ch. 5
9/29		Exam 1 (3:30 – 5:30 pm)	
10/6	Theory: Modeling of ideal suspended growth reactors (cont.)	HW 3 assigned	GDLF Ch. 6
10/13	Biological nutrient removal		GDLF Ch. 7 and 12
10/20	Applications: Suspended growth reactors	HW 3 due, HW 4 assigned	GDLF Ch. 10 and 11
10/27	Anaerobic processes	HW 4 due	GDLF Ch. 8 and 14
11/3		Exam 2 (3:30 – 5:30 pm)	
11/10	Hyperion wastewater treatment plant tour		Notes
11/17	BioWin modeling workshop Modeling of attached growth reactors	Proposal due for topic presentation (email to instructor)	GDLF Ch. 17
11/24	Modeling of attached growth reactors (cont.)	HW 5 assigned	GDLF Ch. 21
12/1	Project presentations	HW 5 due, Field trip project due	Notes
12/15		Final exam (2:00 - 4:00 pm)	

Professional Organizations:

Water Environment Federation - WEF (www.wef.org)
Student membership $20 (including local membership of Michigan WEA).
Membership includes free registration for WEFTEC, WEF Specialty Conferences, and WEF Webcasts; discounts on WEF technical manuals and books; access to Career Resources tool and WEF Job Bank; a subscription to *Water Environment & Technology* and *Federation Highlights*; and several other benefits (see website for details).
"Founded in 1928, the Water Environment Federation (WEF) is a not-for-profit technical and educational organization of 36,000 individual members and 75 affiliated Member Associations representing water quality professionals around the world. WEF members, Member Associations, and staff proudly work to achieve our mission to provide bold leadership, champion innovation, connect water professionals, and leverage knowledge to support clean and safe water worldwide"
"WEF and its Members:

- research and publish the latest information on wastewater treatment and water quality protection;
- provide technical expertise and training on issues including non-point source pollution, hazardous waste, residuals management and groundwater;
- sponsor conferences and other special events around the world;
- review, testify, and comment on environmental regulations and legislation."

International Water Association - IWA (www.iwahq.org)
Student membership $53, Membership includes a subscription to *Water 21*.
"The International Water Association (IWA) is the global network of 10,000 water professionals spanning the continuum between research and practice and covering all facets of the water cycle. Through its network of members and experts in research, practice, regulation, industry, consulting and manufacturing, IWA is in a better position than any other organisation to help water professionals create innovative, pragmatic and sustainable solutions to challenging global needs.
The strength of IWA lies in the professional and geographic diversity of its membership — a global mosaic of national, corporate and individual member communities. The IWA network is structured to promote multi-level collaboration among its diverse membership groups, and to share the benefit of knowledge on water science and management worldwide. The Association helps make the right connections at the right time, thereby sharing cutting-edge research and practice that allows the water sector shape its future."

American Water Works Association - AWWA (www.awwa.org)
Student membership ~$28, membership includes a subscription to online versions of two periodicals, the *Journal AWWA* and *Opflow* and *MainStream*.
"AWWA is the authoritative resource for knowledge, information, and advocacy to improve the quality and supply of water in North America and beyond. AWWA is the largest organization of water professionals in the world. AWWA advances public health, safety and welfare by uniting the efforts of the full spectrum of the entire water community. Through our collective strength we become better stewards of water for the greatest good of the people and the environment."

Association of Environmental Engineering and Science Professors - AEESP (www.aeesp.org)
Student membership $15.
"The AEESP is made up of professors in academic programs throughout the world who provide education in the sciences and technologies of environmental protection. Founded in 1963 as a private nonprofit organization, AEESP has grown to more than 800 members in universities throughout the world. The Association assists its members in improving education and research programs, encourages graduate education, and serves the profession by providing information to government agencies and the public, and provides direct benefits to its members."